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Which bioflocculation related characteristics correlate most with membrane bioreactor filtration performance?

Data

Activated sludge characteristics

- ML(V)SS
- Hydrophobicity
- Surface charge
- Floc morophology
- Particle Size Distribution
- eEPS / SMP
- …

PLS

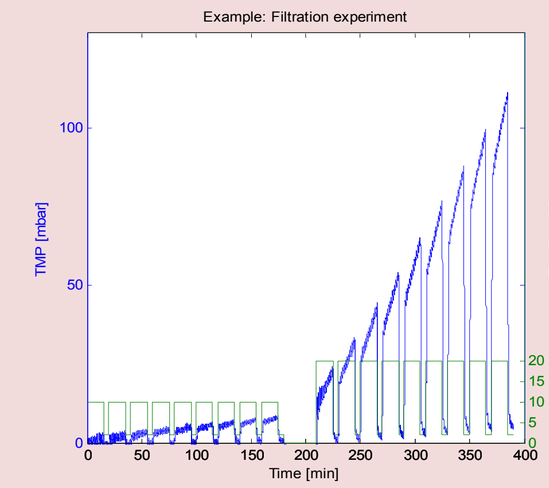
- Multivariate regression techique
- Recombination of existing variables into new ones (PLS components)
- Maximum covariance between sludge characteristics and filtration performance

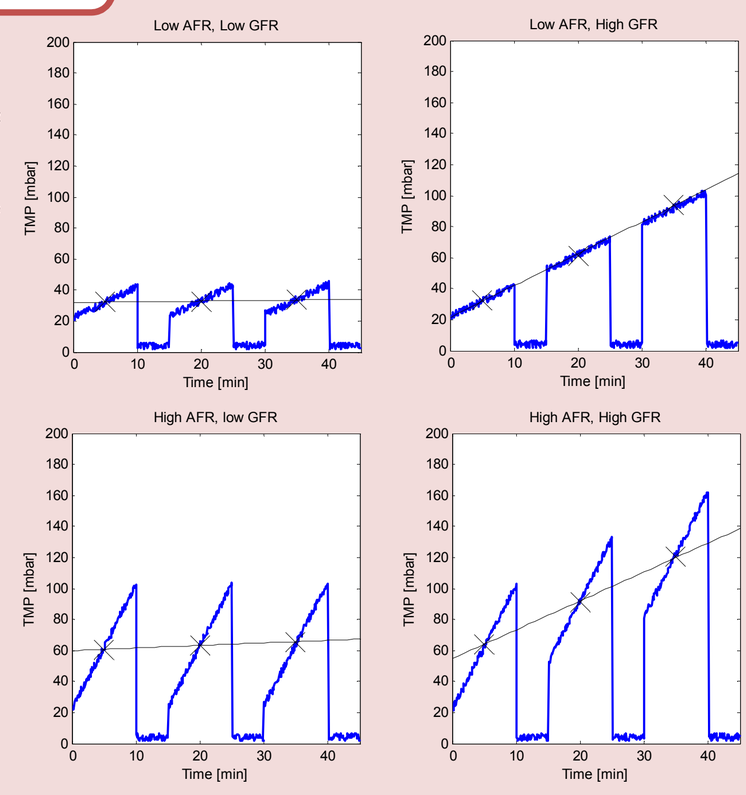
Filtration performance

Filtration performance

Flux driven - 2 fluxes: 10 & 20 L/m²h
Transmembrane pressure (TMP) measured

Average fouling rate (AFR)	Reversible fouling	TMP increase during each filtration step averaged over the 9 steps
Global fouling rate (GFR)	Irreversible fouling	Global TMP increase over the different filtration/relaxation steps

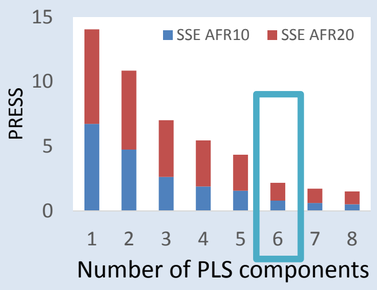




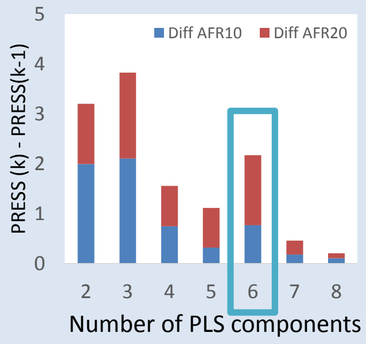
PLS results

10 sludge samples (4 municipal, 6 industrial)

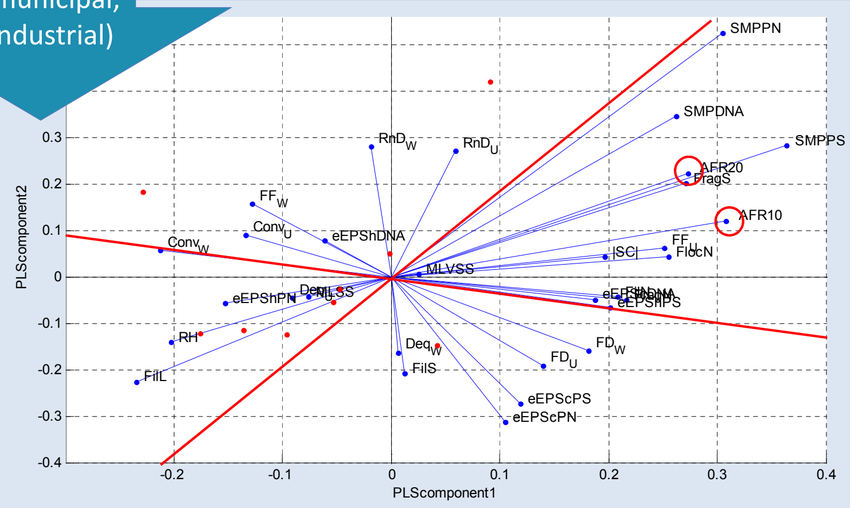
Sum of squared prediction errors (PRESS)



PRESS reduction per component

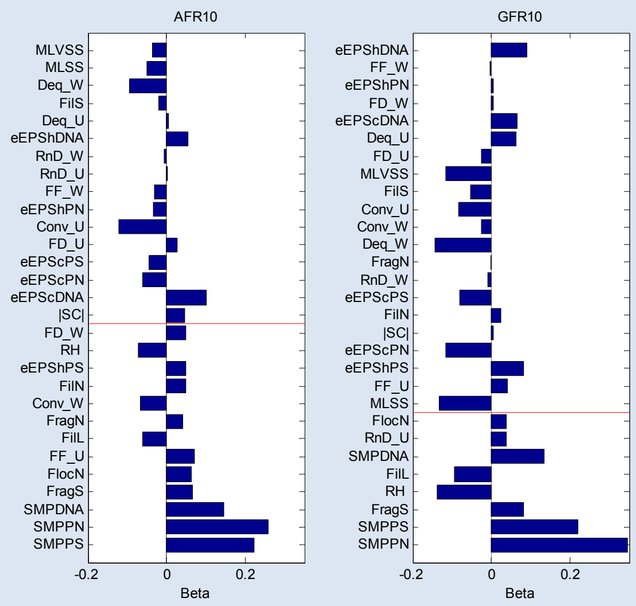


Model Performance	AFR	GFR
Goodness of fit (R^2Y)	0.9965	0.9914
Goodness of prediction (Q^2Y)	0.7808	0.5722



PLS loadings

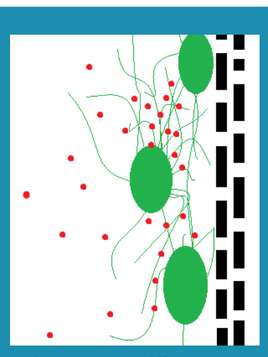
- Graphical representation of variables recombination
- Distance from origin reflects variable importance
- Grouped variables are directly correlated
- Variables across the origin are inversely correlated

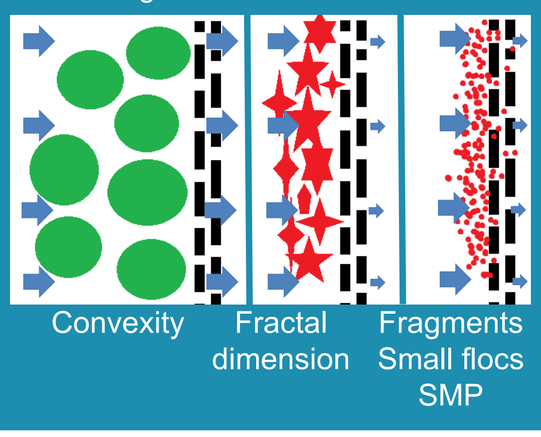


PLS regression coefficients

- Indicate influence on fouling
- Variables below the red line ➔ high influence

Conclusions





	Which sludge characteristics are of influence on		
	Reversible & Irreversible fouling	Only reversible fouling	Not statistically influential
Reduces fouling	Avg. filament length Hydrophobicity (%)	Convexity (W)	ML(V)SS Convexity (U) Equivalent diameter (W)
	SMP (PS, PN, DNA) Fragment surface/Mpix Floc number/Mpix	Fractal dimension (W) eEPS(PS_{HEAT}) Filaments/Mpix Fragments /Mpix Form factor (U)	Surface charge
Increases fouling			

eEPS (PS_{CER}, PN_{CER}, DNA_{CER} , PN_{HEAT}, DNA_{HEAT})
Filament surface/Mpix ; Avg. equivalent diameter (U) ; Roundness (W); Form factor (W); Fractal dimension (U)

(U) = unweighted average, (W) = average weighted with floc size
PN = proteins, PS = polysacharides, $_{HEAT}$ = heat treatment, $_{CER}$ = cation exchange resin

Important factors for fouling:

- Colloidal COD, SMP and fragments increase reversible and irreversible fouling
- Hydrophobic flocs reduce fouling
- Long filaments might create “secondary membrane structure”
- Floc morphology is more important for reversible fouling
- Role of eEPS is not clear
- Weighing morphological variables with floc size is important
- More data needed!